NATURAL GAS FED PC25C FUEL CELL POWER PLANT

FINAL REPORT FOR THE U.S. DEPARTMENT OF ENERGY

Covering Field Experience

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Submitted and Prepared by:

CLC S.r.l.
Via N. Lorenzi 8
16152 Genoa, Italy
Principal Author: Giancarlo Costa

ABSTRACT

This report details the performances obtained during the first year of operation by the Natural Gas Fed PC25C™ Power Plant installed in the city of Varberg (Sweden).
The owner of the power plant is Vattenfall AB a Swedish power production and distribution company.
The power plant is installed close to a hotel and it is connected to the electrical utility.
Information is provided on the resulting electrical and thermal performances, reliability and Mean Time Between Failure factors and moreover an evaluation and details of the cost benefits.

TABLE OF CONTENTS

1. EXECUTIVE SUMMARY

Vattenfall AB started operation with PC25C^{TM} phosphoric acid packaged fuel cell power plant in July 1997.
This power plant was the second natural gas fed PC25C in Europe; in 1992 in Sweden a PC25A fuel cell power plant has been installed by Sydkraft and it has already exceeded 34.000 operating hours.
The results achieved by this PC25C^{TM} power plant are equivalent to those obtained by the other ones.
At present PC25C^{TM} power plants installed in Europe are twenty-one and they have exceeded 350.000 operating hours; the total energy produced is about 55.000 MWh.

2. INTRODUCTION

Benefits of electrochemical energy conversion from PC25C phosphoric acid fuel cell power plants are:

- very low pollutant emissions
- relatively high efficiency in the sub-megawatt range
- low noise and vibration
- potential for longer time between scheduled and unscheduled shutdown maintenance than engine driven system
- ability to perform scheduled quarterly maintenance while the power plant is operating.
- high quality power

World PC25 fleet has exceeded 2 millions operating hours demonstrating the performance availability of such power plant.

These results place base for a real policy of “dispersed generation”; distributing generation throughout a utility system can offer the benefits of reduced transmission and distribution cost by deferring capital expenditures for distribution system equipment and minimizing the costs of upgrading or reconditioning power lines.
Of particular interest are “premium power” applications. In this mode the power plant normally dispatches to the grid at a full 200 KW output. However, if the grid experiences a problem, the fuel cell reconfigures itself to support a grid independent load. This concept produces the most attractive set of fuel cell economics as the fuel capital cost is spread over the maximum power production since the power plant is operating at a full 200 KW output dispatch level most of the time while concurrently adding value by supporting a premium power grid independent load. The existing model C design requires a 3,5 to 5 second break when switching modes from grid dispatch to supporting a premium power grid independent load in the case of a grid upset. However, in the future it may be possible to have a seamless changeover built into the power plant.

3. RESULT AND DISCUSSION

The values of the parameters indicated afterwards are related to the first operating year (July 1997-August 1998).

MTBF = 623 hours

Time reliability = 62%

Time reliability is defined as: $\frac{T ? (S ? U)}{T ? S}$

Energy reliability = 68%

Energy reliability is defined as: $\frac{200 ? T ? ? (P_{r,S} ? S) ? ? (P_{r,U} ? U)}{200 ? T ? ? (P_{r,S} ? S)}$

where:

T time plant is required to be in service

S time for scheduled maintenance events that effects the power plant's ability to generate power

U time for unscheduled events that effects the power plant's ability to generate power

200 nominal electric power output

P_{rS} power reduction at a certain scheduled maintenance event

P_{rU} power reduction at a certain unscheduled event

Mean net thermal output 132 KW (based on running hours)
Mean net electric output 192 KW (based on running hours)

Revenues

Electric	35.200 USD
Heat	36.200 USD

Expenses

Gas	72.900 USD
Maintenance	17.000 USD

Net cost benefit -18.500 USD

MTBF value (623 hours) is equivalent to those values obtained by the first PC25C power plants. It is important to consider that the PC25C model is quite different than PC25A.
The reliability values are also affected by the revisions of some sub system and components of the power plants.
In fact the MTBF value is now about 1.000 hours and there are the technical conditions in order to achieve the foreseen target of 2.000 hours.

4. CERTIFICATION

CLC S.r.l. and Vattenfall AB certify that it has complied in all respects with the grant under DE-FG21-96MC33364, Climate Change Fuel Cell Program and that the related efforts required by that grant are now fully complete including twelve months of operation and submission of the Final Report herein supplied. Such report is in compliance with Paragraph 4 of DoE's Special Terms and Conditions for Research Projects Grants for Climate Change Fuel Cell Program.

5. CONCLUSIONS

Phosphoric acid fuel cell power plant fleet experience confirms that the benefits (see chapter 2) arising from the use of this technology are real.
Of particular interest in the future is the very low pollutant emission also considering the Kyoto Protocol.
Another interesting application of this power plant is premium power; in this mode the power plant normally dispatches to the grid the set point level power.
If the grid causes a trouble, the power plant can detect that and can reconfigure itself to support a grid independent load.

Particularly promising applications are:

- Hospitals and health care facilities and generally the buildings having favorable thermal recovery potentials and where at least some importance is attached to power quality and reliability.

- Selected or isolated locations having grid capability constraints where long, expensive, or time-consuming capacity upgrades are otherwise required.

- Data centers, communication facilities, and manufacturing plants where power quality and grid reliability are of particular concern.